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charine material. Coffee grounds, if made into a powder as fine as flour, is worth experimenting with, since they contain as unexpectedly large percentage of fat and a like proportion of protein, and during the process of baking no caffein could remain should there be any unextracted alkaloids in them. Some crackers made by us and flavored with cinnamon or ginger have proven quite palatable. As to their value as a dietary, it will take some time to determine and give any satisfactory report.

Prices of corn starch flour January 10, 1917: 100 pounds (Chicago), $3.05; 100 pounds (Lawrence), $3.29.

From *Bakers Weekly*, December 2, 1916. File. Addenda to article for Kansas Academy of Science, January 12, 1917.

Determining the Strength of Flour.

PROF. T. B. WOOD, Cambridge University.

After seven years of investigation the author has worked out the following theory on the strength of wheat flours, which has finally enabled him to devise a method which promises to be both accurate and rigid, and to require a very small amount of flour. The strength of a wheat may be defined as the power of making a large loaf of good shape and texture. Evidently strength is a complex of at least two factors, size and shape, which are likely to be quite independent of each other. Not infrequently, for instance, wheats are met with which make large loaves of bad shape or small loaves of good shape.

A FEASIBLE IDEA.

It seemed a feasible idea that the size of the loaf might depend on the volume of gas formed when the yeast was mixed with different flours. On mixing different flours with water and yeast it was found that for the first two or three hours they all gave off gas at about the same rate. The reason of this is that all flours contain about the same amount of sugar, approximately 1 per cent, so that at the beginning of the bread fermentation all flours provide the yeast with about the same amount of sugar for food. But this small amount of sugar is soon exhausted, and for its subsequent growth the yeast is dependent on the transformation of some of the starch of the flour into sugar. Wheat, like many other seeds, contains a ferment or enzyme called diatase, which has the power of changing starch into sugar, and the activity of this ferment varies greatly in different wheats. The more active the ferment in a flour, the more rapid the formation of sugar. Consequently the more rapid the yeast will grow, and the greater will be the volume of gas produced in the later stages of fermentation in the dough.

ESTIMATING THE SIZE.

From these facts it is quite easy to devise a method of estimating how large a loaf any given flour will produce. Twenty grams of flour are weighed out and put into a wide-mouthed bottle. A flask of water is warmed at 40° C. Of this, 100 cc. is measured out and into 2½ grams of compressed yeast is intimately mixed, 20 cc. of the mixture being added to the 20 grams of flour in the bottle. The flour and yeast water are then mixed into a cream by stirring with a glass rod. The bottle is then placed in a water bath, which is kept at 35° C. The bottle is connected to an apparatus for measuring gas, and the volume of gas given off every hour is recorded. As already mentioned, all flours give off about the same volume of gas during the first three hours. After this length of time the volume of gas given off per hour varies greatly with different flours. Thus a flour which will bake a large loaf gives off under the conditions above described about 20 cc. of gas during the sixth hour of fermentation, whilst a flour which bakes a small, light loaf, gives off during the sixth hour of fermentation only about 5 cc. gas. Having devised a feasible method of estimating how large a loaf of any given flour will make, the problem of the shape and texture still remains. Previous investigators had exhausted almost every chemical property of gluten in their search for a method of estimating strength. The author therefore determined to study its physical properties. Now gluten is what is known as a colloid substance. Such substances can scarcely be said to possess definite physical properties of their own, for their properties vary so largely with their surroundings. Their properties are profoundly modified by the presence of chemical substances. Wheat, like most all plant substances, is slightly acid, and the degree of acidity varies in different samples. Accordingly the effect of acids on the physical properties of gluten was investigated and it was found that by placing bits of gluten in pure water and in acid of varying concentration it could be made to assume any consistency from a state of division so fine that the separate particles could not be seen except by noticing their presence made the water milky, to a tough coherent mass almost like India rubber. It was found, however, that the concentration of acid in the wheat grain was never great enough to make the gluten really coherent.

CHEMICAL ANALYSES.

But wheat contains also varying proportions of such salts as chlorides, sulphates and phosphates, which are soluble in water, and the action of such salts on gluten was next tried. It was at once found that these salts, in the same concentration as they exist in the wheat grain, were capable of making gluten coherent, but that the kind of coherence produced was peculiar to each salt. Phosphates produce a tough and elastic gluten such as is found in the strongest wheats. Chlorides and sulphates, on the other hand, make gluten hard and brittle, like the gluten of very weak wheat.

The next step was to make chemical analyses to find out the amount of soluble salts in different wheats. Strong wheats of the Fife class were found to contain not less than one part of soluble phosphate in 1,000 parts of wheat, while Rivet wheat, the weakest wheat that comes on the market, contained only half that amount. Rivet, however, was found to be comparatively rich in soluble chlorides, and in very small amounts in strong wheats of the Fife class. After making a great many analyses it was found that the amount of soluble phosphate in wheat was a very good index of the shape and texture of the loaf which it would make. The toughness and elasticity of the gluten no doubt depend on the concentration of the soluble phosphate in the wheat grain, the more soluble the phosphate the tougher and more elastic the gluten, and a tough, elastic gluten holds the loaf in shape as it expands in the oven and prevents the small bubbles of gas running together into large holes and spoiling the texture.

MEASURING TURBIDITY.

These facts suggest at once a method for estimating the shape and texture of a loaf which can be made from any given sample of wheat. An analysis showing the amount of soluble phosphate in the sample should give the desired information. But unfortunately such analysis is not an easy one to make and requires a considerable quantity of flour. In making these analyses it was noticed that when the flours were shaken with water to dissolve the phosphate, and the insoluble substances removed by filtering, the solutions obtained were always more or less turbid, and the degree of turbidity was found to be related to the amount of phosphate present and to the shape of loaf produced. On further investigation it was found that the turbidity was due to the fact that the concentration of acid and salts which make gluten coherent also dissolve some of it, and gluten, like other colloids, gives a turbid solution. It was also found that the amount of gluten dissolved, and consequently the degree of turbidity, is related to the shape of the loaf. Now it is quite easy to measure the degree of turbidity by pouring the solution into a glass vessel below which a small electric lamp is placed and noting the depth of the liquid through which the filament of the lamp can just be seen. The turbidities, however, were so slight that it was found necessary to increase them by adding a little iodine solution, which gives a brown milkiness with solution of gluten, the degree of milkiness depending on the amount of gluten in the solution.

THE METHOD.

The method is as follows: One gram of flour is weighed out and put into a small bottle. To it is added 20 cc. of water. The bottle is then shaken for one hour. At the end of this time the contents are poured into a filter. To 15 cc. of the solution 1½ cc. of a weak solution of iodine is added, and after standing an hour the turbidity test is applied. Working in this way, it is possible to see through only 10 cc. of the solution thus obtained from such wheat as Red Fife, as compared with 25 cc. in the case of Rivet. Other wheats yield solutions of intermediate capacity.

Corn Oil.

L. E. SAYRE.

Corn oil is defined by the United States Government as "the edible oil obtained from the germ of corn, maize (Zea Mays L.) (Food Inspection Decisions 169). Of this oil there was manufactured in the United States in the year 1916 (later figures are for the moment not available) approximately eighty-two million pounds. As this oil is a by-product from the corn starch and similar industries, it can be manufactured and sold more cheaply than can those vegetable oils which are primary products of manufacture.